reduce the occurrence of glare and Newton's rings when the top structure **340** is brought into contact with the bottom structure **345**. The roughened surface of the spacers **316** and protective layer **318** reduces the visibility of the spacers **316** and the layer **318** in a transparent sensor, allowing larger spacers to be used for control of touch activation force, if desired. In addition, the index of refraction of the top and bottom layers **340, 345** may be adjusted to increase optical transmission through the sensor. As discussed previously, the gap **315** between the top and bottom layers **340, 345** may optionally be filled with a deformable, elastic material.

[**0050**] In another embodiment of the invention, shown schematically in **FIG.** 3B, the top protective layer is not present. The bottom protective layer **318** includes integrated spacers **316**.

[**0051**] Another approach for maintaining the distance between the top and bottom layers, described with reference to FIGS. 4A-4D, is to fill the gap with a material having appropriate mechanical properties to maintain the separation between the top and bottom layers. Typically, this material is compressible so that the upper structure may approach the lower structure under the application of a touch, and is also resilient, so that the upper structure rebounds to its equilibrium position once the touch is removed. In some embodiments, the material is not expelled from the region of the touch, and so the conductive layers do not come into contact with each other. The gap filler material may also be loaded with particles, for example, glass particles that act as spacers to maintain a minimum separation between the conductive layers **410, 420**.

[**0052**] In the embodiment of a touch sensor shown in **FIG. 4A, a** flexible top structure **440** includes a supporting layer **405**, first conductive layer **410** and may also include a protective layer **412**. The layers **405**, **410** and **412** forming the top structure **440** are typically composed of flexible materials so as to permit the structure **440** to flex under an applied force. A bottom structure **445** includes an optional substrate **430**, a second conductive layer **420** and may also include a protective layer **418**. The bottom structure **445** may be flexible or rigid. The top and bottom structures **440, 445** are separated by a gap **415** that is filled with a gap filling material.

[**0053**] **FIGS. 4B and 4C** schematically illustrate other embodiments of the invention in which a gap filler material is used to separate the conductive layers. The touch sensor may be configured with only one protective layer **418** disposed on the bottom conductive layer **420** as shown in **FIG. 4B**. Alternately, the protective layer may be disposed over the top conductor **410**. Where one or more protective layers **412** and **418** are used, the protective layer or layers may be relied on to prevent contact between the conductive layers **410** and **420**, and so the gap filler material may be expended from the location of the touch.

[**0054**] Furthermore, the touch sensor may be configured without protective layers, for example as schematically illustrated in **FIG. 4B**. In such a case, the gap filler material is designed to prevent contact between the conductive layers **410** and **420** and is, therefore, not expended from between the conductive layers **410** and **420** at the location of the touch.

[**0055**] Another embodiment is schematically illustrated in **FIG. 4D**. In this embodiment, the gap **415** includes a layer **450** that is embedded with particles **452**, for example glass particles, that are relatively hard to compress. The particles **452** may have a size equal to the thickness of the layer **450** (as shown), or may be smaller than the thickness of the layer **450**. There is at least one compressible layer **454**, for example formed from an elastomer, between the layer **450** and one of the conductive layers **410** and **420**. In the particular embodiment illustrated, there is a compressible layer **454** between the layer **450** and each of the conductive layers **410** and **420**. When the user touches this touch screen, the compressible layer **454** or layers compress under the force of the touch, allowing the upper conductive layer **410** to approach the lower conductive layer **420**, thus altering the capacitance between the two layers **410** and **420**.

[**0056**] One approach used to detect a two dimensional touch location on a touch sensor according to an exemplary embodiment of the invention is a 5-wire technique. **FIG. 5** illustrates a block diagram of a 5-wire touch sensing system for detecting the location of a touch on a touch sensor. The system includes a two dimensional (x,y) touch sensor **510** and a controller **520**. The touch sensor **510** is based on a closed detection circuit that permits the sensor to be used in a handheld device, such as a personal digital assistant, mobile telephone, or the like. Furthermore, the signal to noise ratio of the sensor **510** is higher than is typically obtained with other capacitive-based touch sensors.

[**0057**] Drive circuitry **530** in the controller **520** injects an alternating electrical signal through contacts **515, 516, 517, 518** located at four different positions on one of the conductive layers of the touch sensor, for example, the top layer **512**. In one configuration, the top layer **512** is rectangular in shape and the contacts **515, 516, 517** and **518** may be located at the four corners of the top layer **512**. The remaining conductive layer, in this case the bottom layer **514**, provides the return path and reference layer for the injected signal. Although the touch sensor is shown in **FIG. 5** as rectangular in shape, the touch sensor need not be rectangular and may have any shape.

[**0058**] The use of the bottom layer **514** as the reference layer advantageously provides shielding for the touch sensor from electromagnetic interference (EMI) originating in a display, such as an LCD or CRT display (not shown), located below the touch screen. This may eliminate the need for an additional conductive layer, usually found in present capacitive touch screens, to act as an EMI shield between the display and the touch sensor. An optional pattern of conductive segments (not shown) disposed on the surface of the conductive layer and coupled to the contacts **515, 516, 517, 518** may be used to linearize the electric field across the surface of the top conductive layer.

[**0059**] Before application of a touch, the drive circuitry generates current flow at each contact **515, 516, 517, 518** through the touch sensor. A touch causes a change in the current from each contact **515, 516, 517, 518** through the touch sensor in proportion to the distance of the touch from the contact **515, 516, 517, 518**. The sense circuitry **530** measures the current at each of the four contacts **515, 516, 517, 518**. The currents measured at each of the four contacts **515, 516, 517, 518** of the touch sensor vary as a function of the touch location. In this embodiment, the location of a touch is determined in the processor **540** by comparing the currents measured at the contacts **515, 516, 517, 518** of the